CHAPTER 32

RED PINE TYPE

TYPE DESCRIPTION

A. Stand Composition

More than 50 percent pine with **red pine** (*Pinus resinosa*) predominant.

B. Associated Species

1. Sandy Soils

Jack pine (*P. banksiana*), **white pine** (*P. strobus*), **quaking aspen** (*Populus tremuloides*), **bigtooth aspen** (*P. grandidentata*), **black oak** (*Quercus velutina*), **red oak** (*Q. rubra*), **white oak** (*Q. alba*), **paper birch** (*Betula papyrifera*), and **red maple** (*Acer rubrum*).

2. Loamy Soils

White pine, black cherry (*Prunus serotina*), **balsam fir** (*Abies balsamea*), **sugar maple** (*Acer saccharum*), **basswood** (*Tilia americana*), **yellow birch** (*B. allegheniensis*), **white spruce** (*Picea glauca*), and **eastern hemlock** (*Tsuga canadensis*). Natural red pine stands do not occur on these soils. These associates are found only in plantations.

C. Soil Preference

Best growth occurs on deep, loose, very well-drained loamy sands or gravels.

D. Range of Habitat Types

In northern Wisconsin the red pine cover type is common on QAE, PMV, AQV, QGCe, QAp, PAm, and AVDe (Kotar et al., 1988). However, the potential for growing large-diameter, high quality trees is good to excellent on most habitat types (see Table 32.1).

Red pine is found in climax association on only a few habitat types and is more frequently a component of successional stages that lead to climax associations dominated by hardwoods or other conifers (Kotar et al., 1988; Coffman et al., 1980). Pine stands, especially on heavy soils, will eventually succeed to hardwood species unless management practices interrupt this strong successional trend.

SILVICAL CHARACTERISTICS*

Species	Red pine
Pollination	April through June
Cones Mature	Mid-August through October of the second year
Seed Dispersal	Begins in October and may continue through winter into following summer. Average seed dispersal is 40 ft. from parent tree.
Good Seed Years	Intervals of three to seven years with bumper crops one in ten years.
Germination	Requires mineral soil; optimum temperature range for germination is 64 to 94°F; more than four hours of full sunlight per day will inhibit germination.

Seed Viability	If moisture is insufficient, seeds may remain viable up to three years. Losses to rodents are severe, however. Viability averages 20 good seeds per cone. Direct seeding requires 15,000 viable seeds (about 5 ounces) per acre.
Seedling Development	Approximately 35 percent of full sunlight (65 to 75 percent crown closure) is recommended for seedling establishment. Frequent rains, at least four inches between May and early July, are critical. Summer drought and high surface soil temperatures frequently kill young seedlings (a surface temperature of 136°F for two hours will kill four-year old red pine). In early fall, sudden drops in temperature, for example, from 32° to 18° in 24 hours or less, may kill young seedlings. During the first summer, seedlings may develop tap roots 6 to 18 inches long, but root penetration of four inches is more commonly observed. Red pine has a strong tendency to form a taproot, but root depth and degree of branching are strongly affected by soil conditions and depth of water table.
Growth	At the end of the first year, wild seedlings are often less than two inches tall. After 4 to 5 years, growth rates speed up but it may take 15 to 16 years for overtopped seedlings to reach breast height; for many years thereafter, height growth may average 1 ft. per year.
Shade Tolerance	Relatively intolerant but will subsist in partial shade. Red pine has been known to respond well to release after 30 years of suppression.
Major Pests	If red pine shoot blight (*Serrococcis strobilinus*) is present, avoid growing red pine in two-storied stands. Red Pine Pest Management Guidelines are included at the end of this chapter.

* Mainly from Fowells (1965).

MANAGEMENT ALTERNATIVES

The management objective should be identified in relation to other land management objectives using the habitat type as the preferred indicator of site potential. Possible alternatives include managing to produce maximum quantity and quality of sawtimber and veneer on appropriate habitat types, or controlling composition and growth of stands so that intermediate thinnings provide saleable products (fiber, posts, poles, cabin logs, pilings, etc.). Shorter fiber rotations are another alternative particularly in the central sands areas.

SILVICULTURAL SYSTEM

Even-age management with periodic thinnings based on basal area control. Less commonly, all-age management in extremely sensitive aesthetic areas.

MANAGEMENT RECOMMENDATIONS

These recommendations encompass purely technical aspects of red pine silviculture to maximize sawtimber quantity and quality, and may be modified to accommodate aesthetic concerns, wildlife habitat, and other forest-dependent resources. It is the professional responsibility of the forester to develop a balanced, integrated silvicultural prescription for each stand being managed.

Some general comments concerning red pine silviculture are listed below:

- Do not reduce stand density to below the B-line, or allow it to surpass the A-line, on the stocking chart (figure 32.2). Within this range (between A- and B-lines), stand growth and merchantable board-foot volume yield are optimized.

- In overstocked stands, thin lightly and frequently, with increasing intensity, for the first several thinnings, to safely develop tree vigor and strength, and until target residual densities (near B-line) are achieved. A general rule of thumb is do not remove (cut) >50% of the basal area in any one thinning operation.

- When red pine stands are managed for poles and pilings, 100 to 110 sq. ft. of basal area residual should be retained in pole stands after thinning.

- It is important to limit logging damage to the remaining trees when thinning; logging wounds can predispose trees to disease and decay.

- Where applicable, crop trees should be selected for pruning in a manner that will complement row thinning.

- Since natural red pine regeneration is unpredictable and seldom achieved, post-harvest re-planting is recommended as the means of regenerating pure stands.

- Habitat type analysis is extremely important in selecting management objectives, as the economics of red pine silviculture may not be favorable if intensive efforts to eliminate hardwoods are needed. On some habitat types, shorter rotations expressly for fiber production may be the preferred management objective.

  Site index data for red pine are presented in Figure 32.1 and Table 32.2.

KEY TO RECOMMENDATIONS

A. Seedling/Sapling Stands (0-5" DBH)

1. Understocked stands (less than 400 stems per acre)	Control competing vegetation. Interplant red pine in seedling stands. Interplant white pine or white spruce in sapling stands.
1. Fully stocked stands	Give all red pine stands full release. If funding allows, consider pruning 150 crop trees per acre to 9 ft. when 18 ft. of height is attained. Thereafter, continue pruning crop trees, as growth allows, to a total height of 17 ft., but not beyond 50 percent of a given tree's height.

B. Poletimber Stands (5-9" DBH)

1. Fully stocked stands	**2**
1. Understocked stands	**3**
2. Distinct rows	Refer to stocking chart (figure 32.2). Thinning should be initiated at or above the midpoint between the A- and B-lines but before stand density reaches the A-line. Reduce stocking to a density near the B-line (70-100 sq. ft. of basal area), choosing a residual basal area that will accommodate landowner objectives. A general rule-of-thumb to thin pole stands has been 90 sq. ft. of residual basal area. Typically, subsequent thinnings are implemented about every 8-12 years thereafter. Apply mechanical row or strip thinning for the first thinning. Typically, every other row or every third row is removed, provided the width between residual rows is wide enough to accommodate processors and forwarders. To achieve desired residual basal area (stocking), a low thinning within the leave rows can be applied concurrently with the mechanical row thinning. To determine the width necessary for successful row thinning, consider the type of harvesting equipment likely to accomplish the task. Many types of harvesting equipment require a minimum of 10 feet and some require up to 15 feet.

	The second thinning can be a low thinning (preferred) or a mechanical row thinning. The third thinning should be a low thinning. In addition to the thinning method, follow the standard order of removal when selecting which trees will remain and which will be cut. Reduce the stand basal area to near the B-line. **Standard Order of Removal for Thinning Red Pine:** **1. High Risk Trees** **2. Release Crop Trees** **3. Undesirable Species (landowner objectives)** **4. Low Vigor** **5. Improve spacing (based on risk, vigor, species, form, crown class, landowner objectives)**
2. Indistinct rows	Refer to stocking chart (figure 32.2). Thinning should be initiated at or above the midpoint between the A- and B-lines but before stand density reaches the A-line. Reduce stocking to a density near the B-line (70-100 sq. ft. of basal area), choosing a residual basal area that will accommodate landowner objectives. A general rule-of-thumb to thin pole stands has been 90 sq. ft. of residual basal area. Typically, subsequent thinnings are implemented about every 8-12 years thereafter. Apply mechanical strip thinning for the first thinning. Systematically designate strips of sufficient width for mechanized access throughout the stand, creating a cut row effect. A cut strip 10 feet wide every 30 feet is similar to thinning every third row. To reduce the number and negative impacts of skid trails, a cut strip 10-12 feet wide every 60 feet with all slash deposited in the cut strip to support forwarder weight is recommended. To achieve desired residual basal area (stocking), a low thinning within the leave strips can be applied concurrently with the mechanical strip thinning. The second and third thinnings should be low thinnings. In addition to the thinning method, follow the standard order of removal (see **2** above for specifications) when selecting which trees will remain and which will be cut. Reduce the stand basal area to near the B-line.
3. Landowner objectives include red pine management, and the habitat type, soil, and site potential are suitable for red pine management.	Clearcut overstory, treat slash, prepare site, and replant to red pine.
3. Landowner objectives indicate a preference for other feasible cover types, or the habitat type, soil, and site potential are not suitable for red pine management.	Convert to another cover type; apply artificial or natural regeneration methods.

C. Sawtimber Stands (>9" DBH)

1. Small sawtimber (9-15" DBH)	**2**
1. Large sawtimber (>15" DBH)	**4**
2. Fully stocked stands	Refer to stocking chart (figure 32.2). Thinning should be initiated at or above the midpoint between the A- and B-lines but before stand density reaches the A-line. Thinning operations typically are operable when basal area is 130-200

	sq. ft. per acre. Reduce stocking to a density near the B-line (90-120 sq. ft of basal area), choosing a residual basal area that will accommodate landowner objectives. A general rule-of-thumb to thin small sawtimber stands has been 120 sq. ft. of residual basal area. Typically, thinnings are implemented about every 10-20 years. Thinnings should be free thinnings (integrating low and crown thinning techniques) or should be either low thinning or crown thinning as needed. Follow the standard order of removal when selecting which trees will remain and which will be cut. **Standard Order of Removal for Thinning Red Pine:** **1. High Risk Trees** **2. Release Crop Trees** **3. Undesirable Species (landowner objectives)** **4. Low Vigor** **5. Improve spacing (based on risk, vigor, species, form, crown class, landowner objectives)**
2. Understocked stands (less than 2 MBF per acre)	**3**
3. Landowner objectives include red pine management, and the habitat type, soil, and site potential are suitable for red pine management.	Clearcut overstory, treat slash, prepare site, and replant to red pine.
3. Landowner objectives indicate a preference for other feasible cover types, or the habitat type, soil, and site potential are not suitable for red pine management.	Convert to another cover type; apply artificial or natural regeneration methods.
4. Fully stocked	Refer to stocking chart (figure 32.2). Thinning should be initiated at or above the midpoint between the A- and B-lines but before stand density reaches the A-line. Thinning operations typically are operable when basal area is 160-240 sq. ft. per acre. Reduce stocking to a density near the B-line (100-150 sq. ft of basal area), choosing a residual basal area that will accommodate landowner objectives. A general rule-of-thumb to thin large sawtimber stands has been 140 sq. ft. of residual basal area. Typically, thinnings are implemented about every 10-20 years. Thinnings should be free thinnings (integrating low and crown thinning techniques) or should be either low thinning or crown thinning as needed. Consider the standard order of removal (see **2** above for specifications) when selecting which trees will remain and which will be cut. Harvest at rotation age.
4. Understocked	**3** (same as for understocked small sawtimber)

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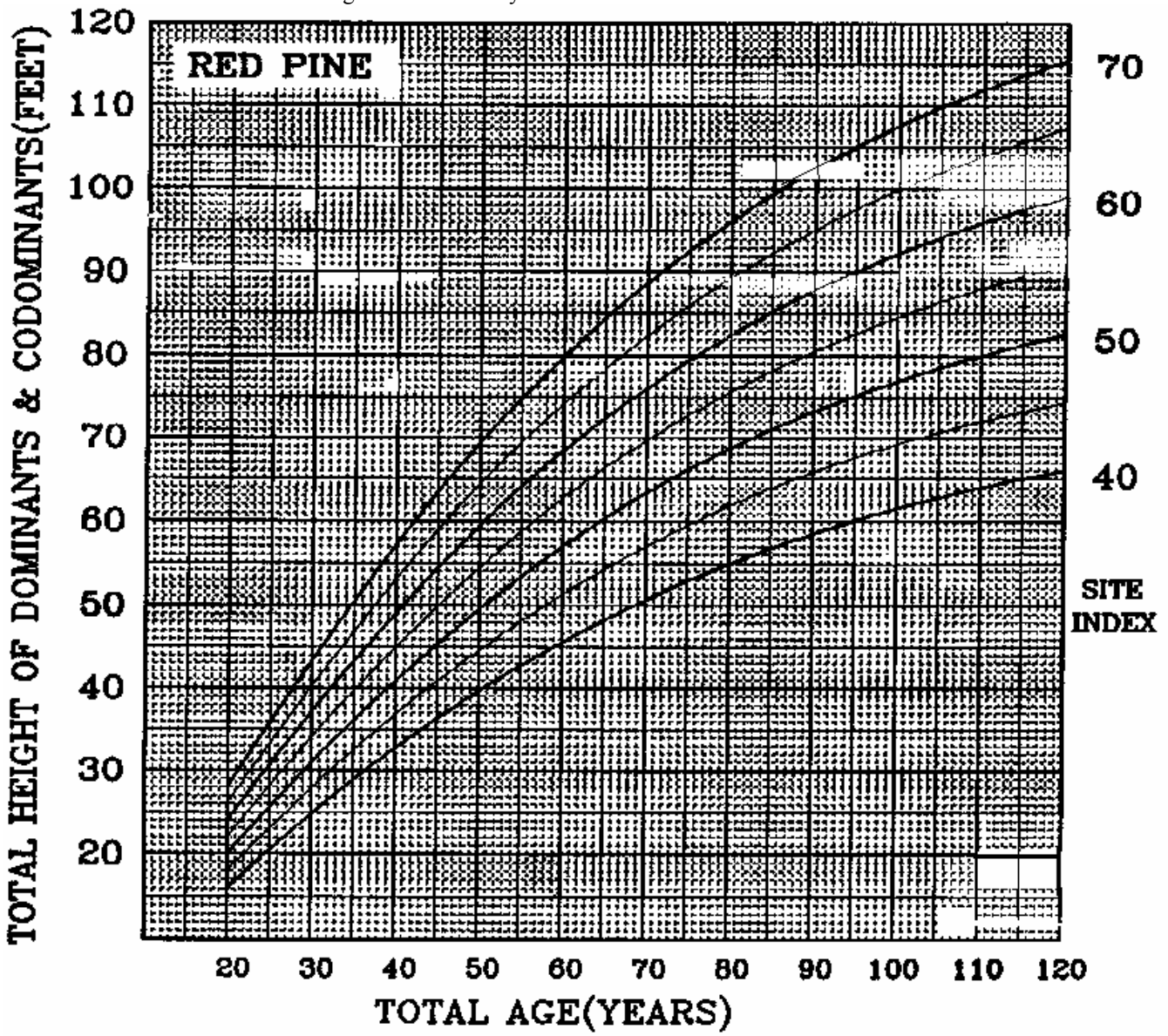
Figure 32.1 Site index curves for red pine (Carmean et al., 1989).

Rotation age: Managed stands -- 90 years.
Unmanaged stands -- 130 years.

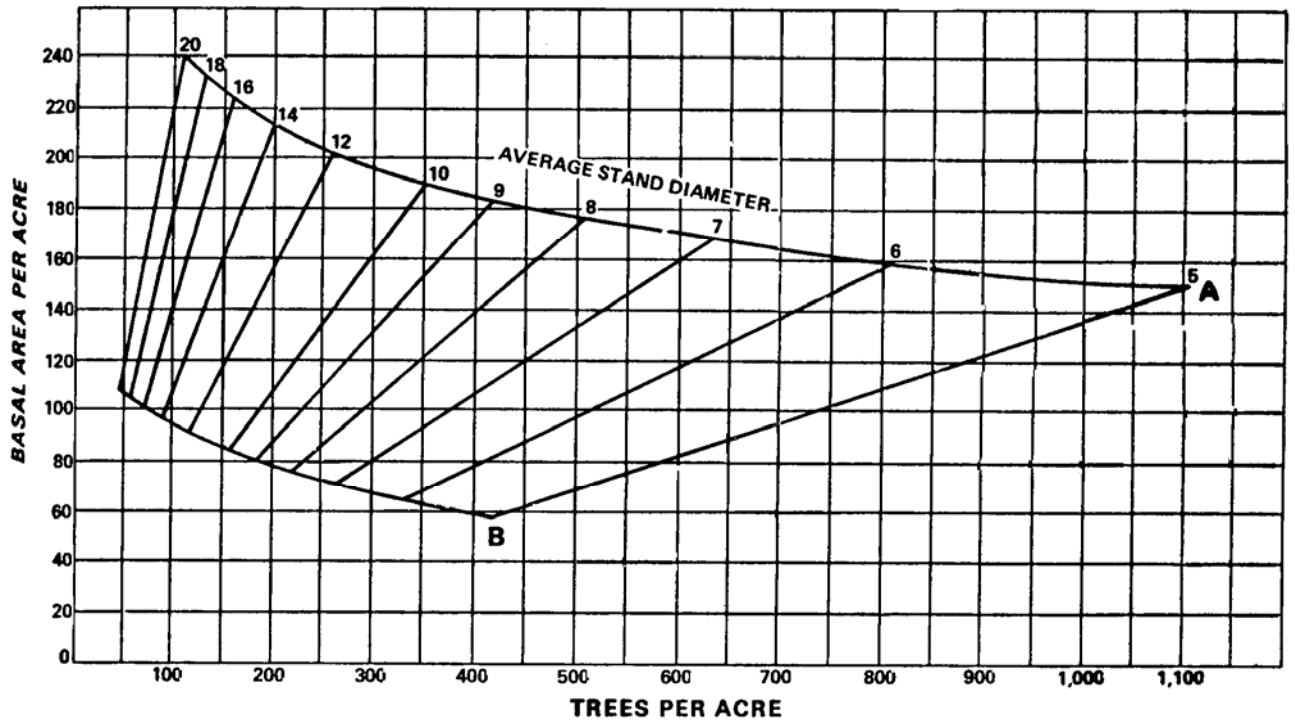


Red pine (Gevorkiantz 1957c, derived from Eyre and Zehngraff 1948, and Brown and Gevorkiantz 1934)
Minnesota
Number of plots and number of dominant and codominant trees not given
Total height and total age, anamorphic, equation not given
Convert d.b.h. age to total age by adding years according to site index (BH = 0.0):

SI:	40	50	60	70+
Years:	8	6	5	4

	b_1	b_2	b_3	b_4	b_5	R^2	SE	Maximum difference
H	1.8900	1.0000	-0.0198	1.3892	0.0000	0.99	0.64	1.4
SI	0.5291	1.0000	-0.019	-1.3892	0.0000	0.99	0.64	1.4

Figure 32.2 Stocking chart for red pine (Benzie, 1977).



Stocking Chart: The area between the A-line and B-line indicates the range of stocking where trees can fully utilize or occupy the site (fully stocked). Within this range, optimum stand growth and volume yield can be maintained. The chart provides a statistical approach to density management based on observed relationships between stand density, growth, and wood value.

A-line: Represents the maximum stocking level that can maintain optimum stand growth and yield. Allowing stand density to surpass the A-line (overstocked) will reduce merchantable board-foot volume growth and yield.

B-line: Represents the minimum stocking level that can maintain (fully occupy the site) optimum stand growth and yield. Reduction of stand density below the B-line (understocked) will reduce stand volume growth and yield.

Thinning: The stocking chart functions as a useful **guide** for when and how much to thin. Target stocking levels are determined based on optimizing stand growth and yield. Stand density is allowed to fluctuate between defined limits (A- and B-lines). The lower limit (B-line) is most important and guides thinning applications. Regular reductions of stand density to the lowest level at which full occupancy is maintained should result in the most rapid diameter growth that can be maintained without reduction in total merchantable board-foot volume yields.

Figure 32.3 Red pine rotation lengths.

Forest Habitat Types by Soil Moisture/Nutrient Classification 1)

	Very Dry/Poor	Dry/Poor	Dry Mesic/Medium	Mesic/Medium-Rich
	QAE	QGCe	PMV	ATM
	QA	AQV	AVVib	AAr
	AQT	AQV-S	AVde	AFD
		QAp	AQVib	ATD
		PAm	AA	AViO
		PMV-P	AC	ACaCi
				AH
Recommended Rotation Length	50-90 years	80-120 years	100-150 years	120-180 years

The recommended rotation ranges are intended to encompass the normal economic rotation on the lower end to the biological rotation on the upper end. The lower number will more closely reflect the age at which the pine on each respective site class reaches the culmination of annual growth and diminishing annual growth begins to set in. The upper rotation length is intended to represent the average age at which biological maturity (decline) commences for each site class.

Individual trees may live longer or decline earlier than these average rotation ages indicate. For example, there are stands of Red Pine in the Central Sands area that are deteriorating at 45 to 50 years of age due to a variety of site and pathogenic conditions.

Richer sites will tend to succeed to more shade tolerant climax species over time. The longer the rotation the more succession will proceed.

State forest managers should also refer to the Big Tree Silvicultural direction in Chapter 11.

Foresters will need to exercise local judgment in applying these rotational criteria.

1) Additional habitats will be added for the southern half of the state when they become available.

Figure 32.4 Flow chart of criteria for selecting method of site preparation (Bassett, 1984).

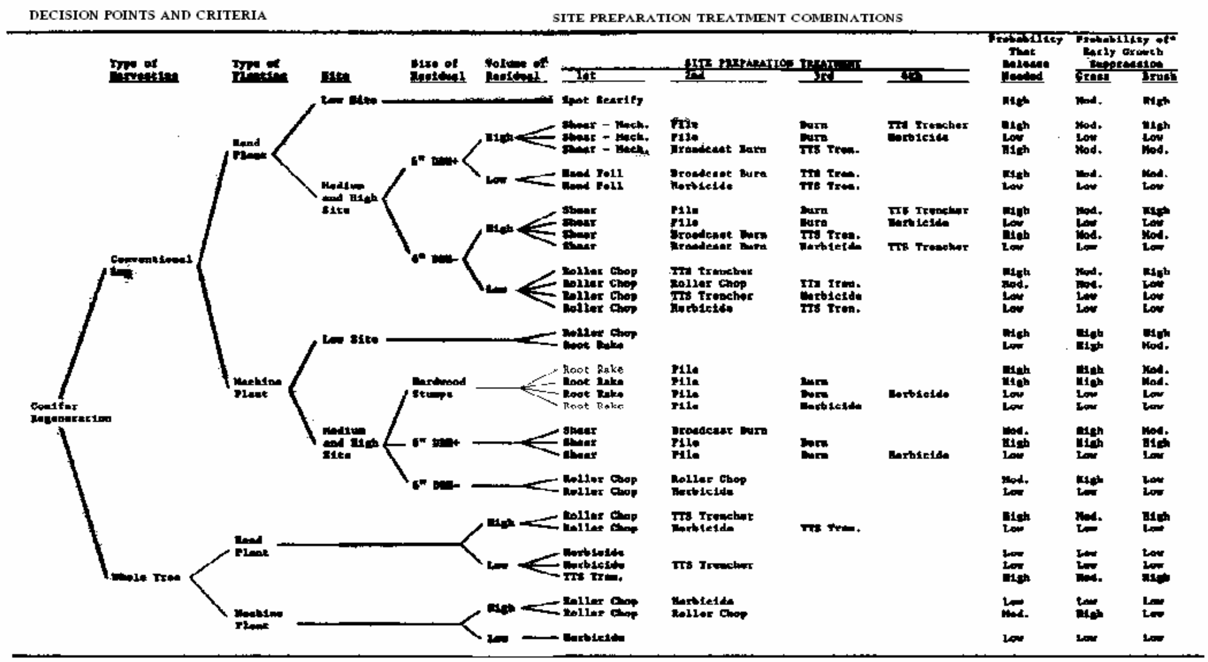


Figure 2. Site preparation alternatives (furnished by M. S. Coffman, R. E. Lee, and R. A. Sirken of Champion Timberlands, Norway, MI).

* High Probability > 70%.
Low Probability < 30%
Moderate Probability 30-70%.

Table 32.1 Habitat types where red pine has been observed. From Kotar et al. (1988).

Habitat type	Dominant component or in pure stands?	Potential for growing large-diameter high quality trees	Competition intensity	Occurs naturally?[1]
QAE	yes	poor	low	yes
AQV	yes	very good	low	yes
QGCe	yes	poor	low	yes
QAp	yes	very good	low	yes
PAm	yes	excellent	moderate	yes
PMV	yes	excellent	moderate	yes
AVVib	yes	excellent	moderate	yes
AVDe	yes	excellent	moderate	yes
AQVib	no	excellent	moderate	yes
AA	no	excellent	strong	yes
ATM	no	excellent	strong	no
AFD	no	excellent	strong	no
ATD	no	excellent	severe	no
AViO	no	excellent	severe	no
ACaCi	no	good	severe	no
AH	no	good	severe	no

[1] Red pine occurs naturally only on the designated habitat types but has been planted elsewhere with mixed results.

Table 32.2 Site index for red pine: 5-year intercept method.*

Intercept (in feet)	Site Index
0 - 3.2	30
3.3 - 4.4	40
4.5 - 5.7	50
5.8 - 7.3	60
7.4 - 10.8	70
10.9+	80

* For use on pine less than 25 ft. tall. For pine over 25 ft. tall, use standard site index curves (Figure 32.1). From Region Nine Timber Management Guide, p. 5.6.

5-year intercept method:

1. Select a dominant or co-dominant tree.

2. Measure the distance between the first and sixth whorl of branches above DBH. This is the intercept value.

3. Read site index directly from chart.

4. Stand site index should be based on measurement of at least three trees.

PEST MANAGEMENT GUIDELINES OF RED PINE WISCONSIN DNR, FOREST PEST CONTROL

HAZARD	LOSS OR DAMAGE	PREVENTION, MINIMIZING LOSSES AND CONTROL ALTERNATIVES	REFERENCES
FOLIAGE PESTS			
Pine Tussock Moth	Within hazard zone, periodic outbreaks of spring and early summer defoliation of sapling and pole stands. Heavy defoliation of red pine is usually associated with presence of jack pine. Defoliation may cause growth loss, top kill and tree mortality.	1. Remove adjacent open-grown jack pine. 2. Spring application of chemical or biological insecticide. 3. Accept defoliation and monitor for tree mortality; harvest if necessary.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
European Pine Sawfly; Red Pine Sawfly	Periodic outbreaks of spring defoliation of sapling and small pole sized stands. Outbreaks are more severe prior to crown closure and in open-grown stands. Heavy defoliation for several years may cause height and radial increment reductions of 80% but seldom causes tree mortality.	1. Promote early stand closure. 2. Virus application on small larvae (European only). 3. Insecticide application on larvae. 4. Accept defoliation and growth loss.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Redheaded Pine Sawfly	Periodic outbreaks of summer defoliation of sapling and small pole stands. Old needles then new needles are eaten. One heavy defoliation causes top kill, forking and tree mortality. HAZARDOUS SITUATIONS: 1. Excessively shallow or disturbed soil. 2. Red pine plantation adjacent to hardwood edge. 3. Excessive competition from grass or braken fern. 4. Open stand caused by poor initial plantation survival.	CURRENT OR IMPENDING OUTBREAKS: ALTERNATIVES: 1. Spray rising populations to prevent major outbreak. (Chemical insecticides are available now; a virus product is being developed.) 2. Allow population to rise and spray to protect foliage. PREVENTION: 1. Avoid planting on these sites or monitor plantations closely. 2. Maintain distance (50 ft.) from hardwood edge. 3. Control weed and grass competition. 4. If initial survival is poor, replant or interplant.	Redheaded Pine Sawfly. L.F. Wilson and R.D. Averill. 1978. USDA-Forest Service, Forest Insect and Disease Leaflet 14. Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.

HAZARD	LOSS OR DAMAGE	PREVENTION, MINIMIZING LOSSES AND CONTROL ALTERNATIVES	REFERENCES
Introduced Pine Sawfly	Occasional widespread outbreaks of spring and summer defoliation of white pine that may also affect red pine. Defoliation of red pine seldom severe.	No prevention available. Direct control seldom necessary; if necessary, spray insecticide on larvae.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Red Pine Needle Midge	Occasional widespread outbreak of late-summer needle browning in pole stands. Heavy injury in upper whorls for 2-3 years greatly reduces growth and may prevent shoot growth.	No prevention or direct controls.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Pine Needle Rust	Occasional heavy spring loss of needles within 5 feet of ground. Seldom serious.	Prevention: Remove alternate host of the fungus (Aster and Goldenrod) by mowing or using herbicides before August when spores are released.	How to Identify and Control Pine Needle Rust Disease. T.H. Nicholls, et al. 1976. USDA Forest Service.
Needle Droop	Mid to late summer drooping and/or browning of needles. Occurs occasion-ally in drought years on course soils only in plantations. Causes some growth loss but seldom kills trees. Buds usually not killed.	1. Control weed competition first 5-10 years. 2. During planting, take care to avoid damage to roots such as jamming or J-rooting.	Needle Droop: An Abiotic Disease of Plantation Red Pine. D.R. Bergdahl, et al. 1976. Plant Dis. Reptr. 60:472-476.

BUD, SHOOT AND TWIG PESTS

Red Pine Shoot Blight	Shoot dieback and subsequent tree mortality of seedlings within hazard zone. Heavy repeated shoot dieback causes mortality of saplings. Infection is usually associated with infected overstory or adjacent infected stand.	Within hazard zone, avoid establishing red pine under red pine overstory; harvest infected stand.	Sirococcus Shoot Blight. T.H. Nicholls, K. Robbins. 1984. USDA Forest Service. Forest Insect and Disease Leaflet 166.
Diplodia Shoot Blight	Mortality of new shoots in mid-summer in trees of all ages. Canker forms that may kill branch, then entire tree. Light infections from wounding are normal. Serious infections and tree mortality occur on dry sites during drought years.	Avoid planting red pine on these sites or sites with a history of serious Diplodia infection.	How to Identify and Control Diplodia Shoot Blight Collar Rot and Canker of Conifers. M.A. Palmer, et al. 1983. USDA Forest Service.

HAZARD LOSS OR DAMAGE PREVENTION, MINIMIZING LOSSES AND CONTROL REFERENCES

		ALTERNATIVES	
Scleroderris Canker	Mortality of trees under ten feet tall in hazard zone. Branch mortality of larger trees in frost pockets.	Within hazard zone, avoid planting in frost pockets. Plant alternative species. Remove all red and jack pine in infected area.	How to Identify Scleroderris Canker. D. Skilling, J. O'Brien. 1979. USDA Forest Service. How to Prevent Conifer Nursery and Plantation Damage by Scleroderris Canker. D. Skilling. 1984. USDA Forest Service.
Red Pine Shoot Moth (see hazard map)	Within hazard zone, beginning at age 20-30 years, new shoots are destroyed in July resulting in main stem deformity height growth loss, volume loss. More serious on drier sites.	ALTERNATIVES: 1. Remove worst stems during thinning. 2. Consider alternate species. 3. No direct controls available.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
A. <u>European</u> Pine Shoot Moth (see hazard map)	Within hazard zone, repeated bud and shoot boring in saplings results in extreme stem deformity until lowest live branches are above snow line.	ALTERNATIVES: 1. Avoid planting red pine in hazard zone. 2. Prune lower branches. 3. Spray with chemical insecticide (seldom practical).	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Saratoga Spittlebug	Sapsucking injury on twigs causing flagging, branch and tree mortality of trees 5-15 years old. When serious, can destroy plantation.	ALTERNATIVES: 1. Remove alternate hosts of spittlebug (Sweetfern and Rubus) when they occupy 20% more of the ground cover. 2. Monitor for saratoga spittlelbug and treat with insecticide if necessary.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Pales Weevil	Adult feeding on bark in spring and fall may cause mortality in seedlings and flagging in older trees. Damage is associated with presence of fresh pine stumps.	ALTERNATIVES: 1. Remove new pine stumps before replanting. 2. Delay planting until stumps are two years old. 3. Treat seedlings with insecticide.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.

HAZARD	LOSS OR DAMAGE	PREVENTION, MINIMIZING LOSSES AND CONTROL ALTERNATIVES	REFERENCES
MAIN STEM PESTS			
Pine Engraver Beetle (Bark Beetles)	Tunneling in inner bark causes mortality in sapling to sawlog sized trees, singly or in pockets. In the spring, beetles build up in any available diseased or storm-damaged pine stems or logging slash. They emerge in summer and attack any surrounding moisture-stressed pines. Mortality is usually limited to a few trees in normal weather but may cover several acres in dry summers. Spring and summer thinning and logging operations may provide material for beetle population build-up, especially during dry years.	Maintain stand vigor by avoiding overstocking and by avoiding overmature stands. If low vigor is due to drought or defoliation, consider presalvage harvest. Storm-damaged material should be harvested or monitored for build-up of bark beetle population. Thinning is best done between September and March. If summer thinning is necessary: 1. Tops should be utilized down to 2-inch top. 2. Leave branches attached to stem wood to speed drying. 3. Remove cut products from stand within 3 weeks of cutting. 4. Beetle population in slash should be monitored; if dangerous level occurs, mangle bark by driving over it with a tracked vehicle or chip slash. If a pocket of trees are attacked, a well-timed harvest of attacked and adjacent low-vigor trees during the growing season will eliminate local population.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Red Pine Pocket Decline and Mortality	Decline and mortality of red pine (20-40 years old) in a circular pocket within a stand. Pocket may consist of two trees to several acres of trees. Over time, pocket enlarges as tree mortality at pocket margin continues.	No effective control is known.	How to Identify Red Pine Pocket Decline and Mortality. K. Klepzig, et al. 1988. USDA Forest Service NA-GR-19.
Red Turpen-tine Beetle	Tunneling under bark causes mortality in sapling to sawlog sized trees that have been weakened by disease, drought or root injury. Seldom serious.	ALTERNATIVES IN PROBLEM AREAS: 1. Remove weakened or damaged trees. 2. Treat or remove stumps after thinning.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
HAZARD	**LOSS OR DAMAGE**	**PREVENTION, MINIMIZING LOSSES AND CONTROL**	**REFERENCES**

		ALTERNATIVES	
Meadow (Mouse Vole Field Mouse)	Gnawing on bark at base of tree during winter results in mortality of trees up to 8 years old. Heavy concentrations of grass support population build-up which may cause in heavy mortality.	ALTERNATIVES: 1. Remove grass before planting. 2. Control grass within 3 feet of young trees. 3. Keep grass mowed.	Meadow Mouse Control. Scott Craven. 1981. Univ. Wisc. Ext. Leaflet A2148.
Shoestring Root Rot (*Armillaria mellea*)	Decays dead hardwood and conifer roots and stumps, then attacks healthy pine roots resulting in mortality of trees of all sizes. Occurs in pockets. New plantings in areas with stumps or dead trees may suffer 10-30% mortality over 15 years.	ALTERNATIVES IN PROBLEM AREAS: 1. Plant with expectation of some losses hear stumps. 2. Remove stumps. 3. Root rake.	Armillaria Root Rot of Red Pine Planted on Oak Sites in Wisconsin. J. Pronos, et al. 1977. Plant Disease Reporter 61:955-958.
Pine Root Collar Weevil	Tunneling under bark at root collar causes mortality of sapling and small pole-sized trees. HAZARDOUS SITUATIONS: 1. Deep planting. 2. Scotch pine within one mile with heavy root collar weevil infestation.	ALTERNATIVES: 1. On sandy soils, plant with root collar no more than one inch deep. 2. On sandy soils, avoid planting red pine or plant to encourage early crown closure and monitor population closely.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Pine Root Tip Weevil	Feeding on roots causes flagging, top kill and tree mortality. Associated with presence of jack pine and/or nutrient-deficient, sandy soil.	On poor sandy soil, remove jack pine from planting site.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
White Grubs	Feeding on roots kills seedlings planted 1-3 years on sandy soils. White grub densities above 0.2 per square foot may cause heavy seedling mortality and stunting of surviving seedlings.	ALTERNATIVES WHEN FACED WITH HIGH POPULATIONS IN PLANTING SITE: 1. Delay planting 1-2 years. 2. Apply insecticide at planting. 3. Plant and accept some mortality.	Wisconsin Woodlands: Identifying and Managing Pine Pests in Wisconsin. H. Goulding. 1988. Univ. Wis. Ext. G3428.
Pocket Gophers	In western Wisconsin, feeding on roots results in mortality of seedlings and saplings. Significant mortality occurs where two or more gopher mounds per acre are present.	ALTERNATIVES: 1. Accept risk of some mortality. 2. Eliminate gophers with rodenticide.	Pocket Gophers. R.M. Case. 1983. Univ. Nebraska Ext. Pocket Gophers in Forest Ecosystems. C.L. Teipner, et al. 1983. USDA-FS Gen. Tech. Rep. INT-154.

Figure 32.4 Hazard maps for red pine.

Scleroderris canker hazard area in Wisconsin

Red pine shoot blight hazard area in Wisconsin

Pine tussock moth hazard area in Wisconsin

European pine shoot moth hazard area in Wisconsin

Red pine shoot moth hazard area in Wisconsin